

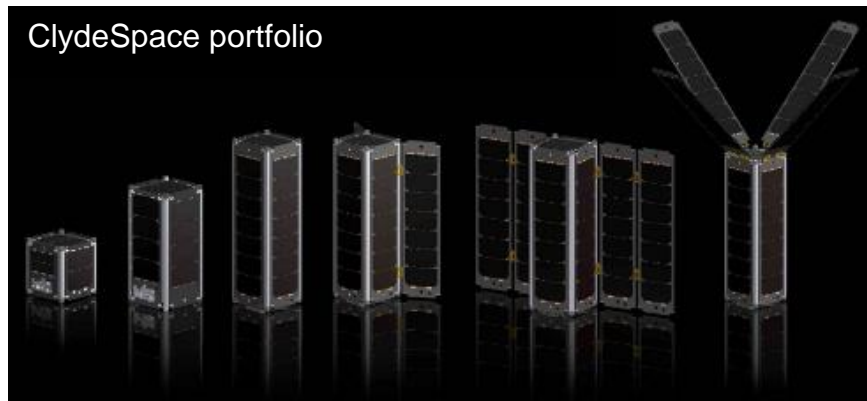


# Lightweight Integrated Solar Array and anTenna (LISA-T)

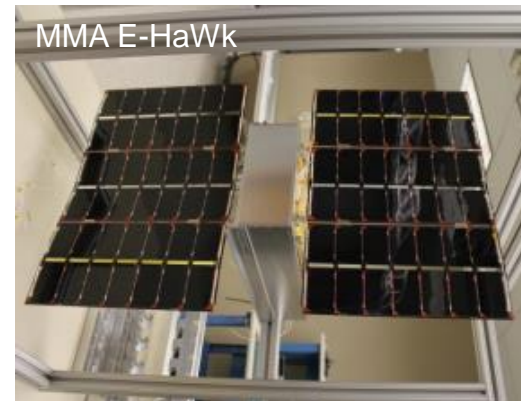


Les Johnson, John Carr & Darren Boyd  
NASA  
George C. Marshall Space Flight Center

- Small-sat surface area, internal volume, and mass are limited resources
- Most limited to 10's of watts electrical power.



2-7W body mounted to 35W deployable



72W deployable

- ... can we increase this to **100's of watts?**

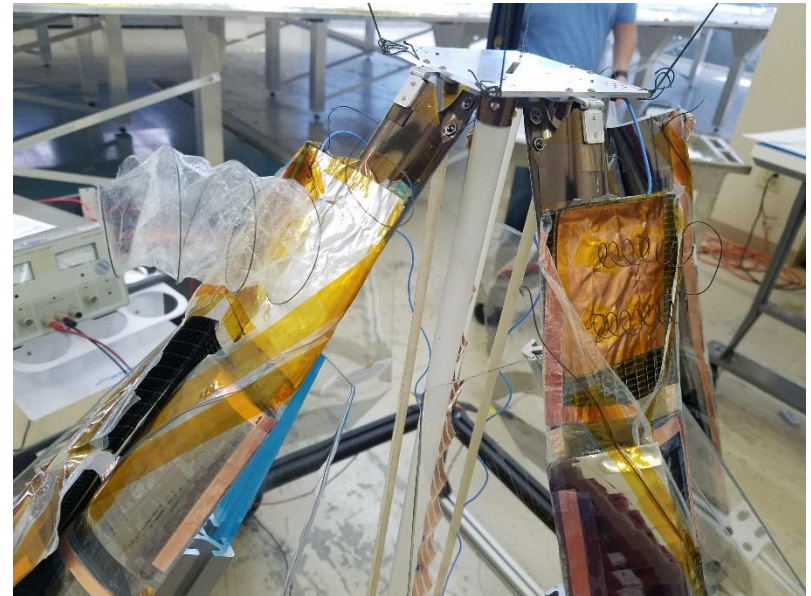


Thin-film

- Thin-film, large area, flexible assemblies: solar sail meet thin-film solar cell
- LISA (Lightweight Inflatable Solar Array) was born



- Add the T (anTenna) by relocating the antenna(s) to deployed blanket
  - Spherical coverage
  - Electronically steered arrays
  - Higher gain design
- Reduced mass, volume, and surface area requirements



*LISA-T emerges*





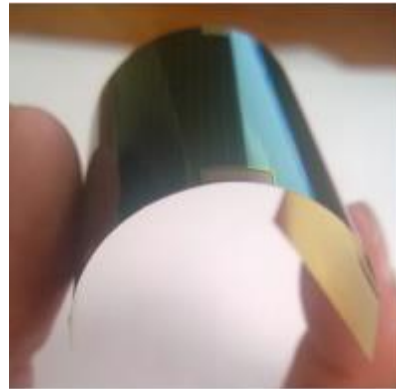
# LISA-T Was Inspired By Confluence of Emerging Technologies

LISA-T is a launch stowed - orbit deployed small-satellite array with embedded lightweight power and communication devices.



NanoSail-D Solar Sail

+



Thin-film IMM PV

+

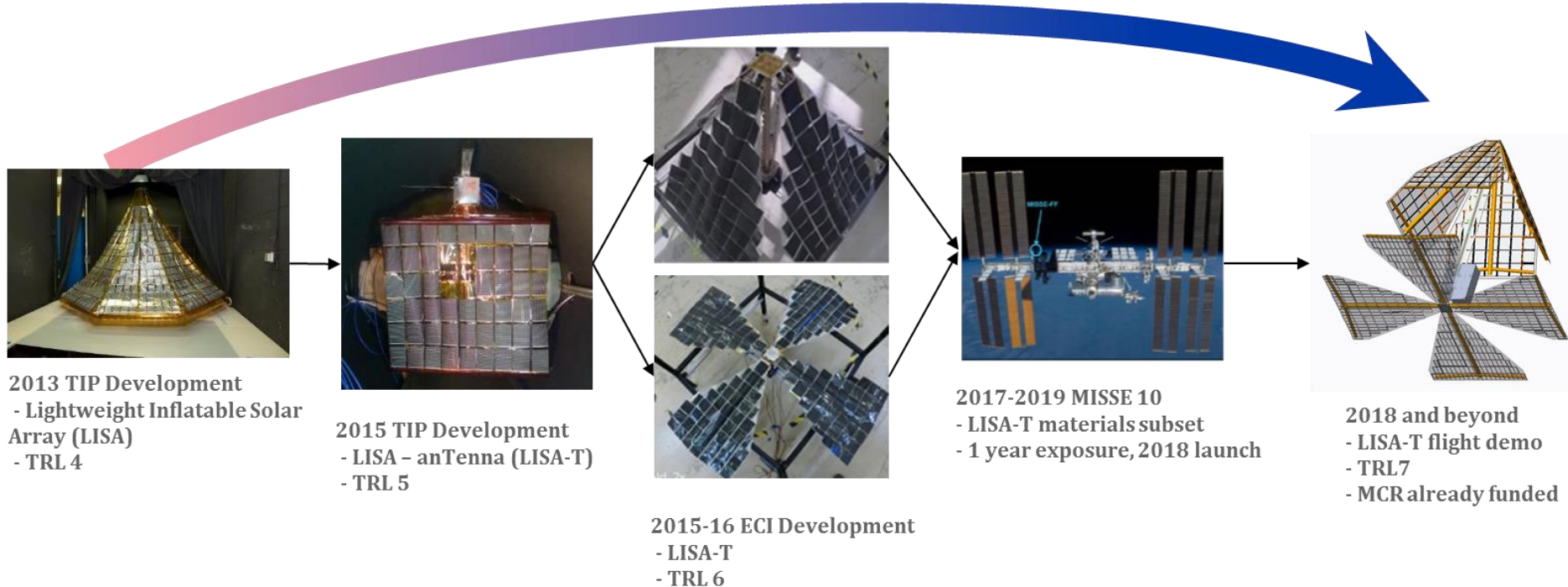


Custom made  
axial mode helical  
antenna



# LISA-T Evolution

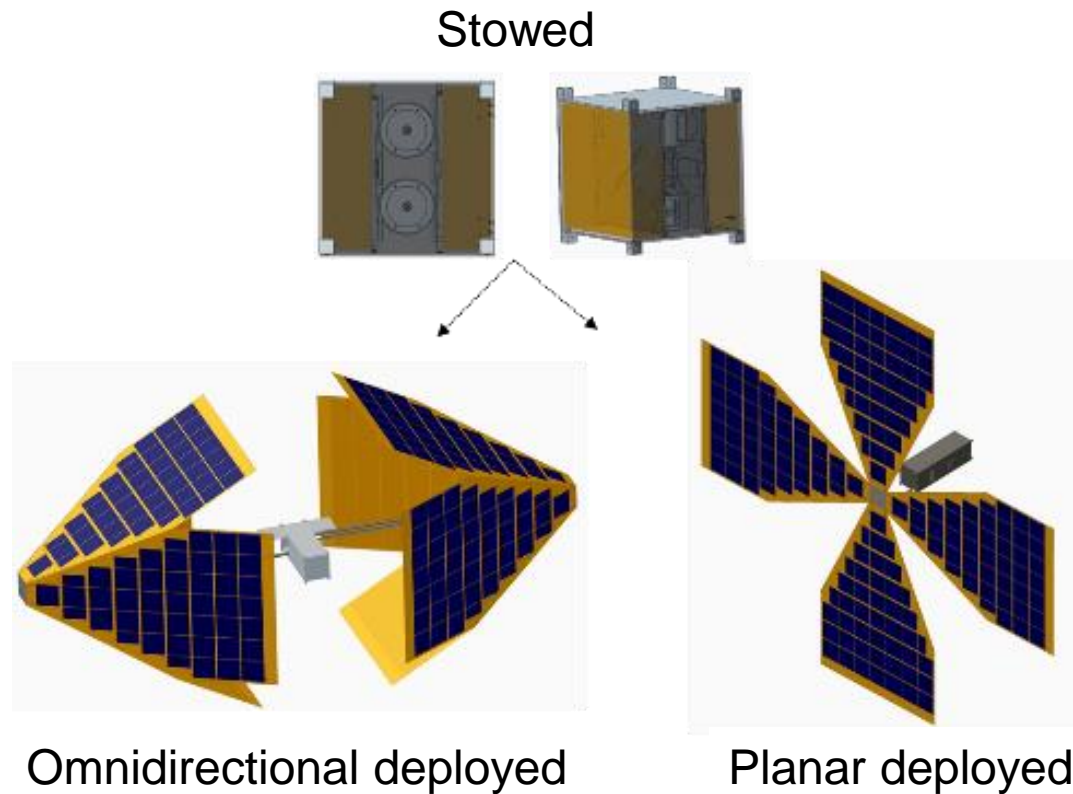
- Rapidly advanced through to Technology Readiness Level 6
- Currently testing for environmental longevity
- Actively pursuing a flight demonstration



LISA-T is a launch stowed, orbit deployed structure on which lightweight flexible photovoltaic and antenna elements are embedded



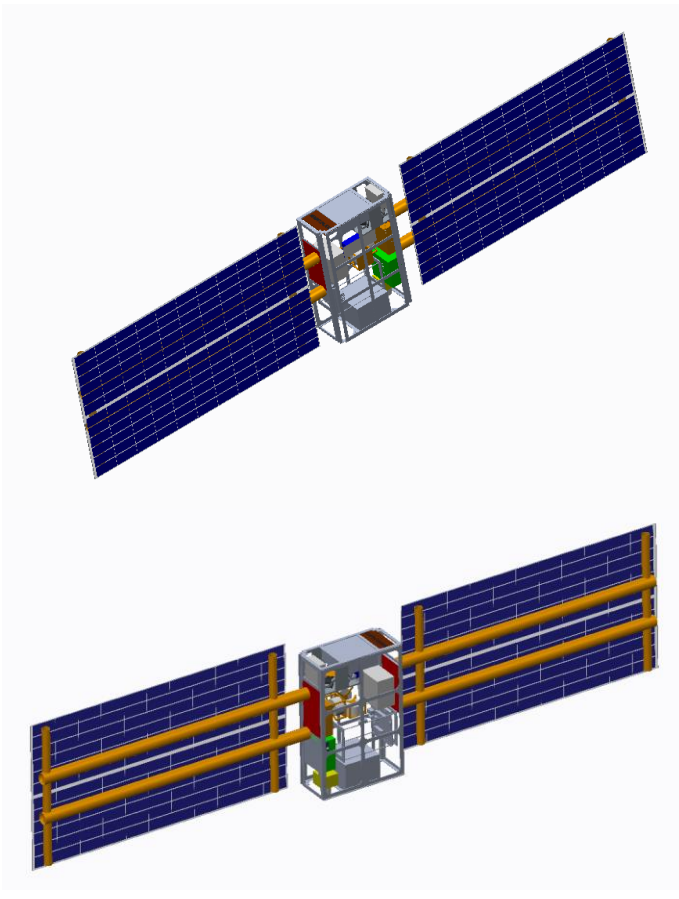
Larger, Lighter, and Better Stowage to improve power generation and communications capabilities in small spacecraft



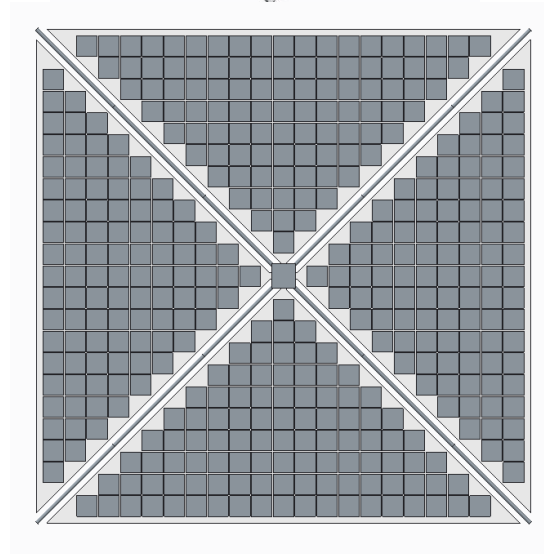
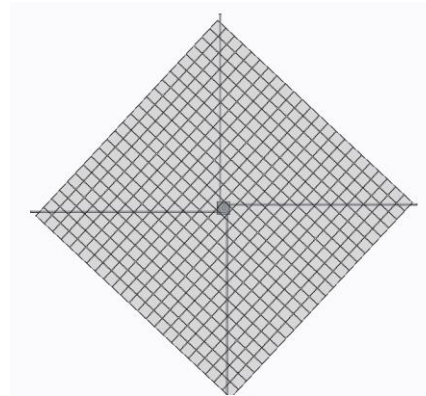
- Omni for GN&C simplicity: Higher power @ similar stowage and mass rates
- Planar for high performance: Much higher power @ higher stowage and lower mass



- Array web as well as deployment backbone can be reconfigured...



'Traditional' rectangular array



1kW Power sail concepts



HISA, Spacesuits  
And beyond

# Power State of the Art

## CubeSat solar array SOA:

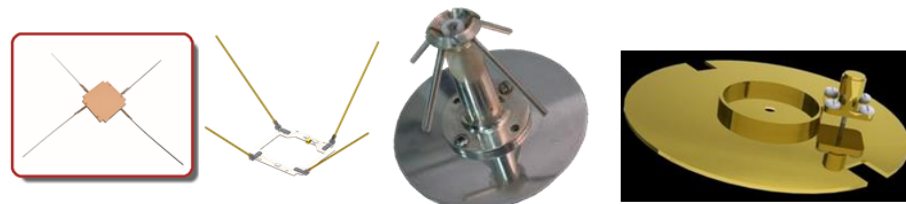
- Rigid panel with triple-junction solar cells; cost tends to increase with larger, more complex arrays.

	Generation Axes	BOL Power (W)	Stowed Power (kW/m <sup>3</sup> )	Specific Power (W/kg)
Clyde Space 3U Body Mounted	2-axes	7.3	~33	~53
MMA HaWK	1-axis	36	~99.0	~130
Clyde Space 3U Deployable	1-axis	29		~54
Tether Unlimited SunMill	1-axis	80	~83	~53
Pumpkin Turkey Tail	1-axis	56	~142	~89
NASA iSAT (2016)	1-axis	72	~45	~58
<b>LISA-T pointed*</b>	<b>1-axis</b>	<b>&gt;250</b>	<b>&gt;400</b>	<b>&gt;250</b>
<b>LISA-T omnidirectional*</b>	<b>3-axes</b>	<b>&gt;125</b>	<b>&gt;125</b>	<b>&gt;125</b>

\*Note: The LISA-T calculations assume a high efficiency >25% thin film cell; lower cost cells can also be used to generate >100W in the pointed and >50W in the omnidirectional configuration.

# CubeSat Antenna State of the Art

## CubeSat antenna SOA: Panel mounted structures



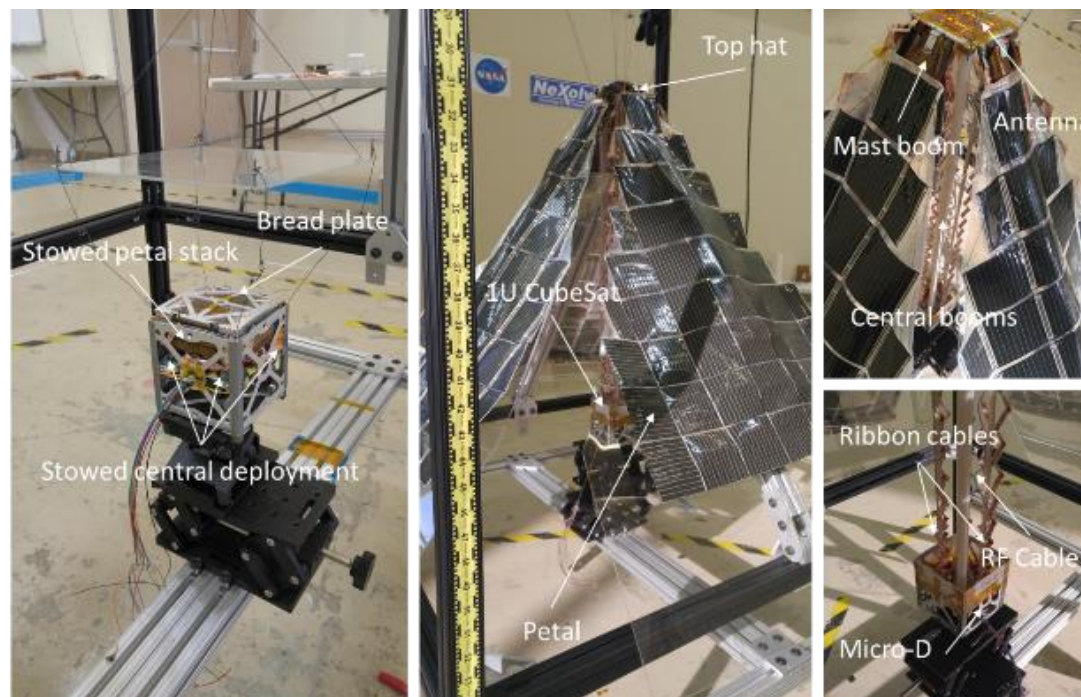
	Band	Main Beam Gain	Type	Directionality
ISIS Deployable	UHF/VHF	0 dbi	Monopole/Dipole	Near omni
NanoCom ANT430	UHF	1.5 dbi	Turnstile monopoles	Near omni
Clyde Space S-Band	S-band	8 dbi	Patch	Pointed
SpaceQuest AC-2000	S-band	2 dbi	Turnstile	Pointed

## LISA-T antenna targets:

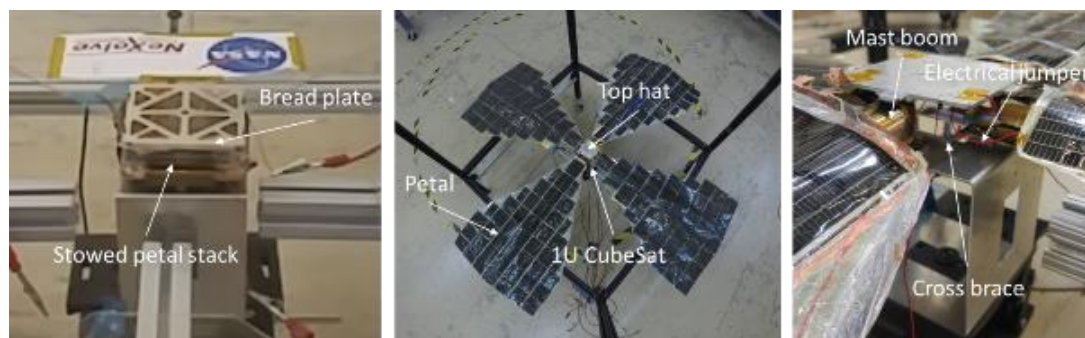
### Deployed structure integrated arrays

	Band	Main Beam Gain	Type	Directionality
Nitinol Dipole Array	UHF	1 dbi	Dipole	Spherical w/array
Nitinol Helical Array	S - X	10 dbi	Axial helical	Spherical w/array
Planar Spiral Array	S	4 dbi	Planar spiral	Spherical w/array
Patch Array	S - X	7 dbi	Patch	Spherical w/array

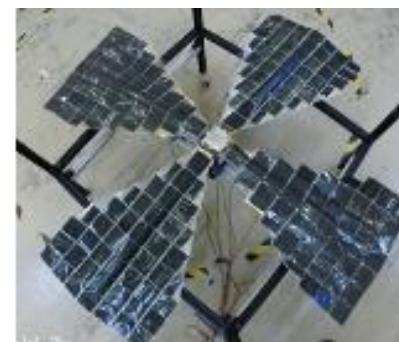
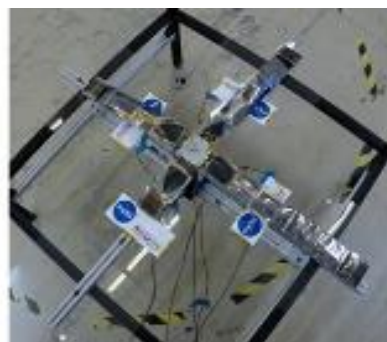
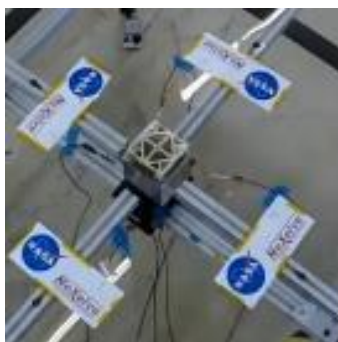
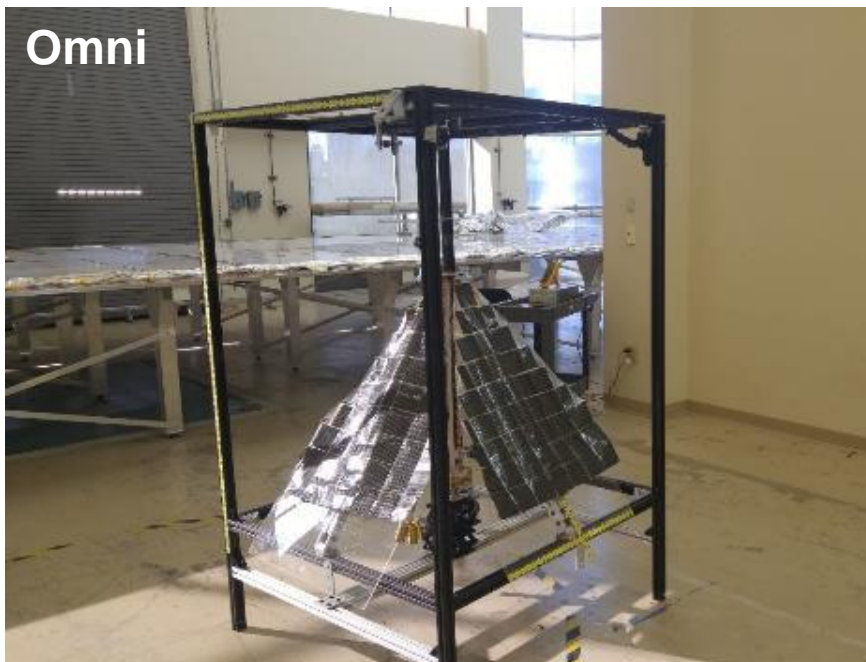
## Omnidirectional



## Planar







Planar deployment progression

- Payload package in  $\leq 2.4U$ ; everything for LISA-T
- 1. Single LISA-T configuration
- 2. All unique, supporting hardware for demo:
  - Array regulation and power management.
  - Communication management
  - Supporting Avionics

